

ENHANCED LEVEL SET SEGMENTATION METHOD FOR DENTAL CARIES DETECTION

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*Dedicated to my beloved parents and family, whom without their love and support this
research would have never been completed.*

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ABSTRACT

Caries detection system is important for dental disease diagnosis and treatment. It can be identified using X-ray imaging. The X-ray image contains interest point of dental to get the teeth information according to specific diagnostic intention. The Region of Interest (ROI) includes the caries area on tooth surface. The imaging challenges like noise, intensity inhomogeneities and low contrast causes the difficulty for identifying correctly the ROI in dental images. According to the recent studies, among all medical image segmentation methods, level set has the best segmentation accuracy. However, there are several components in the level set that need to be enhanced to determine the exact boundary to separate the ROI. The signed force function to control the direction of level set evaluation process, speed function to control the speed of movement and Initial Contour (IC) generation to obtain a more accurate ROI require an enhancement for the better accuracy. In this research, a new enhancement of segmentation method has been proposed based on finding an accurate outcome. The method includes two phases: IC generation and intelligent level set segmentation. In addition, caries detection process is performed with new detection method. To generate the IC for dental X-ray images, a new local IC selection for level set method is proposed. Statistical and morphological information of image is extracted to establish a technique that is able to find a suitable IC. In the second phase, statistical information of the pixels inside and outside the generated contour and linear motion filtering is used to construct the region-based signed force function to provide more stabilisation to proposed method. Furthermore, 31 features of image are extracted to train the neural network and to generate proper speed function parameter. The results of proposed method provide the high accuracy and efficiency in the process of getting teeth boarder. The next process is to detect from the segmented images. The research also proposed a new method using integral projection and feature map for every single tooth to obtain the information of caries area. The achieved overall performance of proposed segmentation method is evaluated at 120 periapical dental radiograph (X-ray), with 90% accuracy rate. In addition, the caries detection accuracy rate on 155 segmented images is 98%.

ABSTRAK

Sistem pengesanan karies adalah penting bagi proses diagnosis dan rawatan penyakit pergigian. Ini boleh dikenalpasti melalui imej X-ray. Imej X-ray mengandungi maklumat penting untuk mendapatkan informasi berkaitan gigi bagi tujuan diagnostik secara khusus. Kawasan Kepentingan (ROI) mengandungi maklumat kawasan permukaan gigi tersebut. Cabaran yang perlu ditangani adalah kekotoran imej, kedalaman cahaya dan rendah kontras menyebabkan ROI bagi imej X-ray gigi tidak dapat dikenal pasti dengan tepat. Berdasarkan kepada kajian semasa terhadap semua kaedah segmentasi imej perubatan, kaedah set tahap adalah kaedah yang memberi nilai ketepatan yang baik. Walaupun begitu, masih terdapat komponen dalam kaedah segmentasi set tahap memerlukan peningkatan kaedah segmentasi dengan menentukan sempadan yang tepat untuk memisahkan ROI. Fungsi daya adalah untuk mengawal arah proses pengujian set tahap, fungsi kelajuan adalah untuk mengawal kadar kecepatan pengembangan dan penjanaan sempadan asas untuk mendapatkan ROI yang lebih tepat memerlukan penambahbaikan untuk mendapatkan ketepatan segmentasi yang lebih tepat. Dalam kajian ini, kaedah segmentasi yang baru telah dicadangkan berdasarkan kaedah set tahap untuk mendapatkan hasil yang lebih tepat. Kaedah tersebut mempunyai dua fasa: iaitu penghasilan Kontur Awal (IC) dan kepintaran segmentasi imej berlandaskan kaedah set tahap. Di samping itu, proses pengesanan karies akan dilaksanakan dengan kaedah pengesanan yang baru. Bagi menjana IC pada imej, satu kaedah IC yang baru untuk kaedah set tahap telah dicadangkan. Maklumat statistik dan morfologi imej diekstrak untuk menghasilkan satu teknik yang boleh mencari IC yang sesuai. Pada fasa kedua, maklumat statistik untuk nilai piksel dalam dan luar kontur yang terhasil dan penggunaan penapisan gerakan linear digunakan untuk menjana fungsi daya berdasarkan kawasan bagi mengawal dan menyediakan lebih kestabilan terhadap kaedah yang dicadangkan. Selain itu, 31 ciri-ciri imej yang telah diekstrak untuk melatih rangkaian neural dan menjana parameter fungsi kelajuan yang bersesuaian. Hasil kajian menunjukkan kaedah yang telah dicadangkan memberi nilai ketepatan yang tinggi dan efisien dalam proses mendapatkan sempadan gigi. Proses seterusnya adalah untuk mengesan karies daripada imej yang telah disegmentasi. Kajian ini turut mencadangkan kaedah baru menggunakan kaedah unjuran integral dan peta sifat yang telah dibangunkan untuk setiap gigi bagi mendapatkan maklumat kawasan karies. Prestasi keseluruhan yang dicapai daripada kaedah segmentasi yang dicadangkan dinilai dengan 120 radiograf gigi periapical (X-ray), nilai ketepatan 90%. Di samping itu, pengesanan karies untuk 155 imej yang disegmentasi adalah pada nilai ketepatan 98%.